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Encouraging the Perceptual Underdog:

Positive Affective Priming of Nonpreferred Local-Global Processes

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Abstract

Two experiments examined affective priming of global and local perception. Participants attempted to detect a target which might be present as either a global or a local shape. Verbal primes were used in one experiment, and pictorial primes in the other. In both experiments, positive primes led to improved performance on the nonpreferred dimension. For participants exhibiting global precedence, detection of local targets was significantly improved, whereas for participants exhibiting local precedence, detection of global targets was significantly improved. The results provide support for an interpretation of the effects of positive affective priming in terms of increased perceptual flexibility.

Keywords: Affective Priming; Positive Emotion; Local and Global Perception

Encouraging the Perceptual Underdog:

Positive Affective Priming of Nonpreferred Local-Global Processes

Much of the world consists of complex entities which may be perceived in terms either of their wholes or their parts. Global processing refers to the procedures involved in perceiving an item in terms of its overall configuration, whereas local processing refers to procedures at the componential level. An important issue in perception (e.g., Kimchi, 1992) is that of the order in which local and global processing proceed within particular circumstances.

An early hypothesis, due to Navon (1977), was that global processing takes precedence over local. Navon introduced a nested letter identification task, in which participants are shown large letters consisting of several smaller letters (e.g., a large S made of small Hs) and are required to identify either the larger letter, which involves global processing, or the smaller letter, which involves local processing. Navon found that responses were faster for the larger, as compared to smaller, letters. In addition, the global letter affected identification of the local letter – such that responses was faster when the letters matched, and slower when the letters were mismatched – while identification of the global letter was unaffected by the local letter.

The finding that performance is better for global than for local forms has been replicated in a number of other studies (e.g., Compton & Weissman, 2002; Dickman, 1985; Love, Rouder, & Wisniewski, 1999; Navon, 1981). Nonetheless, several factors can minimise or even reverse global superiority. For instance, it can be influenced by context, as well as certain qualities of the stimuli including overall visual angle, sparsity, number of elements, and goodness of form (e.g., LaGasse, 1993; Lamb & Robertson, 1990; see also Greaney & MacRae, 1992). Recent evidence – in particular, the results of studies by Gasper and Clore (2002) and Baumann and Kuhl (2005) – suggests that a person's emotional state can also influence how the perception of complex stimuli is structured. A prominent proposal (e.g., Gasper, 2004) is that this occurs because different emotions are associated with different attentional strategies. However, an alternative proposal (Baumann & Kuhl, 2005) is that different emotions are associated with different levels of attentional flexibility. These two theories can be viewed as deriving from relatively general accounts of the relations between emotion and cognition, as follows.

Affect and Information Processing

A number of studies suggest that happy moods promote the use of heuristic processing strategies and a reliance on general knowledge structures that are readily accessible, whereas sad moods encourage systematic processing strategies. Thus positive feelings appear to promote the increased use of stereotypes (Bodenhausen, Kramer, & Susser, 1994), whereas individuals in sad moods have been found to be more likely than those in happy or neutral moods to avoid using stereotypes when forming judgements about people and instead to show more systematic judgement-making by preferring to utilise individuating information (Bless, Schwarz, & Wieland, 1996). In addition to stereotypes, individuals in happy moods have also been found more likely to favour other accessible strategies such as the use of heuristics, scripts, and schemas (Bless, Clore, Schwarz, Golisano, Rabe, & Wolk, 1996; Isen, Means, Patrick, & Nowicki, 1982).

It has been argued that happy moods prompt a less analytical route because positive affect decreases cognitive resources and impairs the ability to process incoming information (Mackie & Worth, 1989). However, support for this view is inconsistent, with happy individuals showing the ability to process information more thoroughly than people in a negative or neutral mood under certain circumstances (Bless, Mackie, & Schwarz, 1992). Instead, the heuristic-versus-analytic view of affect may be explained in terms of an extension of the affect-as-information approach (Martin, Ward, Achee, & Wyer, 1993; Schwarz & Clore, 1983), which proposes that emotions guide processing when they are considered relevant to the task being performed. According to this approach, positive feelings are taken as an indication that the current situation is satisfactory and contains no imminent threat, and thus signal that it is sufficient to rely on less demanding heuristic strategies. In contrast, negative feelings imply that the situation is problematic, and thus signal that information should be processed in a more analytic manner, with increased reliance on external cues (Clore, Schwarz & Conway, 1994). This could also be interpreted to mean that a more top-down processing style is adopted during positive moods while more bottom-up processing occurs during negative moods.

Almost in contradiction to the hypothesis that positive affect encourages the use of easily accessible strategies, is the proposal that it encourages attentional broadening. According to the broaden-and-build theory of Fredrickson (1998, 2001), positive emotions broaden momentary thought-action repertoires and facilitate play and exploration, whereas negative emotions narrow momentary thought-action repertoires in order to promote quick and decisive actions necessary to deal with immediate danger. Using eye-tracking technology, Wadlinger and Isaacowitz (2006) found that individuals in positive moods demonstrate increased attention to peripheral images (providing that the images are not negative), and exhibit more looking around when attending to neutral scenes, compared to individuals in a neutral mood.

Similarly, there tends to be less processing of peripheral cues in negative states such as anxiety (Easterbrook, 1959). Individuals experiencing happy moods are more likely to consider fringe exemplars of categories as category members than are those in a neutral mood (Isen & Daubman, 1984), whereas depressed people form narrower categories than elated or neutral individuals when carrying out an open-ended categorisation task (Murray, Sujan, Hirt & Sujan, 1990).

Related to the broaden-and-build theory is the proposal that positive affect increases flexibility and creativity in processing. Individuals experiencing positive feelings have been found by Isen, Daubman, and Nowicki (1987) to be better at tasks requiring creativity, such as the candle task of Duncker (1945) and the Remote Associates Test of Mednick, Mednick, and Mednick (1964). They also give more unusual first-associates to neutral words in a word association task (Isen, Johnson, Mertz, & Robinson, 1985), and show increased flexibility (reduced anchoring) when reasoning (Estrada, Isen, & Young, 1997). The relationship between negative moods and cognitive flexibility is less straightforward, however. Some studies with clinically depressed participants have indeed shown that severe negative affect is associated with more rigid, inflexible thoughts (Grant, Thase, & Sweeney, 2001; Merriam, Thase, Haas, Keshavan, & Sweeney, 1999); but this is not a universal finding (Fossati, Amar, Raoux, Ergis, & Allilaire, 1999). Further evidence from non-clinical populations has also proved to be not entirely consistent (Rader & Hughes, 2005; Dreisbach & Goschke, 2004).

Affect and Global versus Local Processing

The general approaches considered in the preceding section differ in their implications for global and local processing. If it is assumed that positive affect encourages heuristic processing and negative affect elicits systematic processing, then it may be argued (Gasper, 2004) that positive affect should encourage global processing because attending to the global level is the more accessible and natural strategy, as evidenced by the phenomenon of global advantage; conversely, negative affect should encourage the increased use of analytic strategies to process detailed visual information located at the local level. Despite its different premises, the broaden-and-build view makes similar predictions. As attentional breadth expands, more of a visual scene is taken in, drawing attention to the global form, whereas a narrowed focus results in missing the big picture and noticing local details instead (Fredrickson, 2004). Because positive affect expands attention it is therefore expected to promote global processing, whereas negative affect narrows attention and thereby promotes local processing. The attentional strategies and attentional breadth approaches may in fact be viewed as two particular instances of a more abstract levels-of-focus hypothesis (Clore, Wyer, Dienes, Gasper, Gohm, & Isbell, 2001), which suggests simply that when affective feelings are regarded as task-relevant information, they guide attention to particular types of information (e.g., global or local) and thus influence the extent to which one type of processing is privileged over the other.

In contrast, a different type of prediction is made by the flexibility hypothesis. Affect does not promote a particular level of focus, but instead governs the extent to which one can overcome such a bias in focusing. If happier moods foster cognitive flexibility, positive affect should make it easier for individuals to diverge from the normal processing strategy. In the case of global precedence, for example, positive emotions would be expected to aid local processing, whereas negative affect would be expected either to decrease flexibility or not to affect it at all (reflecting the inconsistent empirical findings), leaving global precedence intact in either case. Thus whereas the other theories considered here have been united in predicting that global precedence should be reinforced by positive affect, the flexibility hypothesis predicts that global precedence should be subverted by positive affect.

Though the relation between trait emotions and global versus local processing had previously been studied (Derryberry & Reed, 1998; Basso, Schefft, Ris, & Dember, 1996), Gasper and Clore (2002) were the first to examine directly the role of mood in global versus local processing. In their experiment, the relevant mood states were induced by asking participants to write about either a “happy and positive” personal life event, a “sad and negative” personal life event or – in the neutral condition – an “average, normal, typical weekday”. Following this, participants performed a matching task introduced by Kimchi and Palmer (1982), where they were required to indicate which of two comparison figures looked most like a given target figure (e.g., three triangles arranged as the corners of a larger triangle). There was no right or wrong answer, but one choice denoted a preference for global processing because it resembled the target figure in its global element (e.g., three squares arranged as the corners of a triangle), whereas the other denoted a preference for local processing (e.g., four triangles arranged as the corners of a square). In accordance with the predictions of the heuristic-versus-analytic and broadening-versus-narrowing approaches, it was found that happy participants were most likely to match the figures on the basis of global features, whereas sad participants made more matches on the basis of local features than neutral participants did.

In a recent study, however, Baumann and Kuhl (2005) found evidence for the hypothesis that positive affect increases processing flexibility. In their experiment, they utilised affective priming to study the effects of extremely short-lived inductions of affect. First, participants recalled personal life events which had made them feel either “happy and positive” or “sad and negative”. Then, they generated words which would prompt these memories and elicit the associated feelings. These words functioned as self-generated affective primes and were presented individually during the experimental task to cause brief, specific, changes in mood. For the experimental task itself, participants were shown large shapes consisting of smaller shapes (e.g., a large triangle made up of small circles) and were asked in each case to decide if a target shape (e.g., circle) was present as either the larger or the smaller shape. Comparing the reaction times taken to detect targets on the two dimensions, Baumann and Kuhl found that positive primes facilitated, and negative primes inhibited, local processing, and attributed the finding to positive affect undermining global precedence by promoting processing flexibility. Why were the results of Baumann and Kuhl (2005) in the reverse direction to those not only of Gasper and Clore (2002) but also other studies in the area (e.g., Basso et al., 1996; Derryberry & Reed, 1998; Fredrickson, 2004; Gasper, 2004)? Baumann and Kuhl argued that the crucial distinction is that previous work examined only processing preferences, whereas they investigated the ability to switch between two types of processing.

The claim that positive affect serves to increase processing flexibility is clearly an important one, and the present study was carried out to investigate it further. Two major questions for probing were identified. First, does affective priming influence local versus global processing even when primes are not idiosyncratic to the individual participant? Second, can local precedence be undermined by increased processing flexibility in the same way that it appears global precedence can?

With regard to the first question, Baumann and Kuhl (2005) used as affective primes sets of self-generated words. As a result, it is possible that their positive and negative primes (which participants had generated to remind themselves of personal life events that were, respectively, happy or sad) differed from each other not only in affective tone but also in some other manner which contributed to the observed effects. To overcome this potential problem, it is necessary to use as affective primes words of known normative properties, which differ in hedonic tone but are matched on other salient dimensions (although this removal of the personally idiosyncratic from the affective prime sets does of course run the risk in principle of reducing the strength of the manipulation).

With regard to the second question, having removed the influence of the individual in the composition of the priming stimuli, it appears appropriate to reintroduce the individual in terms of the issue of global versus local precedence. As noted previously, it has been recognised since the original work of Navon (1977) that there is often an overall tendency for global processing to occur more quickly. However, the overall tendency reflects a stochastic distribution in which not only the magnitude but the direction of precedence varies. This is particularly relevant to the processing flexibility approach, because it means that its predictions are a function of individual differences in precedence, as observed in the pioneering study of Baumann and Kuhl (2005). If a majority exhibit global precedence and a minority exhibit local precedence, then the effect of positive affect in terms of enhanced flexibility is to promote local processing in the majority and global processing in the minority. Thus there is expected overall to be a limited shift towards local processing but, more revealingly, participants partitioned in terms of their initial precedence category should tend to change in opposite directions. That is, positive affect should promote local processing in those exhibiting global precedence, and should promote global processing in those exhibiting local precedence. This possibility forms the main empirical focus of the present study.

Experiment 1

Method

Participants. These were 64 students (33 men and 31 women) at the University of Warwick, with a mean age of 21.4 years. Participants were tested individually in each experiment reported here.

Materials. For the local and global stimuli, four shapes (triangle, circle, square, and diamond) were used at each level. Examples of stimuli for the target *circle* are shown in Fig. 1, representing matching at (a) local, (b) global, or (c) neither level; stimuli never matched the target at both local and global levels. They were similar in structure to those used by Baumann and Kuhl (2005), but contained fewer local elements. Three sets of six words each were selected as affect primes (see Appendix) from the norms of Toglia and Battig (1978). They were allocated to positive (e.g., *rejoice*), neutral (e.g., *account*), and negative (e.g., *nervous*) sets on the basis of their pleasantness values, and were matched on word length, number of syllables, concreteness, imagery, meaningfulness, and familiarity. Presentation of the stimuli was carried out on a desktop computer display using E-prime software. Stimuli were shown in black on a white background, with a height and width dimension of 6 mm and 49 mm for local and for global, respectively. Prime words were also presented in black on white, with mean letter height 11 mm (Courier New 24 bold).

Design and procedure. Participants were first presented with all 18 of the affect primes, and judged the pleasantness of each word. Following Toglia and Battig (1978), a scale of 1 to 7 was used and instructions focused on the ability of words to evoke pleasant or unpleasant feelings. The purpose of this task was to ensure that participants would be sensitive to the affective content of the primes in the following shape detection task.

For the shape detection task, each participants was presented with four blocks of stimuli (prior to these four blocks, there was also a demonstration block and a practice block, in order to familiarise participants with the task). There was a single target shape in each block, with the order of the four target shapes randomised for each participant. Each block consisted of 36 randomised trials. On each trial, a blank screen (800 ms) was followed successively by a fixation cross (500 ms), a single prime-word (400 ms), another blank screen (450 ms), and a local-global stimulus which remained until the participant responded. Within each block, the target shape was present on the global dimension alone in 25% of trials, present on the local dimension alone in 25% of trials, and absent in the remaining 50% of trials. Within each of these three types of trial, equal numbers of trials had positive, neutral, and negative primes. The *m* and *z* keys were used for *present* and *absent* responses, respectively. Reaction times and error rates were recorded automatically, with data analysed only for trials where a target was in fact present.

Results

Pleasantness. As expected there was a significant difference in pleasantness judgements for words used as positive, negative, and neutral primes, $F(2,126) = 808.15$, $p < .001$, $\eta_p^2 = .928$. Bonferroni-adjusted pairwise comparisons showed that judgements were higher for positive primes ($M = 5.71$, $SD = 0.56$) than for neutral primes, ($M = 4.28$, $SD = 0.52$), $F(1,63) = 271.95$, $p < .001$, $\eta_p^2 = .812$, and higher for neutral primes than for negative primes ($M = 1.86$, $SD = 0.59$), $F(1,63) = 986.31$, $p < .001$, $\eta_p^2 = .940$.

Shape detection. Participants were divided into two groups on the basis of their mean reaction times to stimuli with neutral primes. There were 34 participants in the global-focus group (lower mean for global than for local targets) and 30 local-focus participants (lower mean for local than for global targets).

A preliminary repeated-measures analysis of variance (ANOVA) was carried out on data from the combined global-focus and local-focus groups, as a function of target dimension (local and global) and prime valence (positive, neutral, and negative). Reaction times were significantly lower for global ($M = 659.01$, $SD = 194.13$) than for local ($M = 685.37$, $SD = 197.87$) targets, $F(1, 63) = 6.92$, $p < .05$, $\eta_p^2 = .099$, but there was no significant effect of prime valence, $F(2, 126) = 1.80$, or interaction between dimension and valence, $F(2, 126) = 1.09$.

When the preceding analysis was repeated with focus (global and local) added as a between-participant factor, focus was found to have no significant main effect, $F(1, 62) = 2.26$, and no significant interaction with valence, $F(2, 124) = 0.60$, but to modify significantly both the effect of target dimension, $F(1, 62) = 20.27$, $p < .001$, $\eta_p^2 = .246$, and the interaction between dimension and valence, $F(2, 124) = 13.92$, $p < .001$, $\eta_p^2 = .183$. To investigate the interaction between focus, target dimension, and valence further, separate ANOVAs were carried out for the global-focus and local-focus groups. As can be seen in Figure 2, for both groups one apparent finding was of a facilitation in the processing of the non-dominant dimension (i.e., local targets for the global-focus group, and vice versa) with positive as opposed to neutral primes.

For the global-focus group, there was a significant main effect of target dimension, $F(1, 33) = 21.67$, $p < 0.001$, $\eta_p^2 = .396$, but not of prime valence, $F(2, 66) = 0.92$. There was also a significant interaction between target dimension and prime valence, $F(2, 66) = 4.64$, $p < .05$, $\eta_p^2 = .123$. Bonferroni-adjusted pairwise comparisons within target dimensions showed that the only significant difference was that reaction times were faster for positive, as compared to neutral, primes for local targets, $t(33) = 1.99$, $p < .05$. In addition, reaction times were lower for global than for local targets for each prime valence: $t(33) = 3.04$, 4.75, and 2.68 for positive, neutral, and negative primes, respectively (all $p < .05$). Error rates for the global-focus group are shown in the upper part of Table 1. ANOVA indicated that there was no significant interaction between target detection and prime valence, $F(2, 66) = 1.28$, and no significant main effect, thus providing no evidence of a speed-accuracy trade-off.

For the local-focus group, there was no significant main effect of target dimension, $F(1, 29) = 2.21$, or prime valence, $F(2, 58) = 1.20$, but a significant interaction between dimension and valence, $F(2, 58) = 9.02$, $p < .001$, $\eta_p^2 = .237$. Bonferroni-adjusted pairwise comparisons within target dimensions showed that that the only significant difference was that reaction times were significantly faster for positive, as compared to neutral, primes for global targets, $t(29) = 2.87$, $p < .05$. In addition, reaction times were significantly lower for local than for global targets for neutral primes only, $t(29) = 4.00$, $p < .001$. Error rates for the local-focus group are shown in the lower part of Table 1. ANOVA indicated that there was no significant interaction between target detection and prime valence, $F(2, 58) = 1.35$, and no significant main effect, thus providing no evidence of a speed-accuracy trade-off. Finally, although ANOVAs for both global-focus and local-focus participants thus indicated no significant effects in the error rates, there was a possible indication of trade-off across conditions in that, both for global-focus participants with local targets and for local-focus participants with global targets, error rates were numerically higher for positive than for neutral and negative primes. However, further analysis confirmed that the overall pattern of interaction between focus, target dimension, and valence could not be attributed to speed-accuracy trade-off because the correlation between reaction time and error rate across conditions was numerically positive, though not significantly so, $r(12) = 0.54$.

Discussion

In this study, a global versus local shape detection task was used to determine whether flexibility in the processing of visual information is modulated by positive and negative affect. A preliminary analysis of the overall data confirmed the existence of a global advantage but showed no significant influence of prime type. This might be expected in light of the claim by Gasper (2004) that mood effects occur only when stimuli are ambiguous and there is a choice as to which dimension should be attended to. However, a closer examination of the data revealed a richer pattern of outcomes.

As noted earlier, individuals differ in their propensity to attend to one dimension over the other. Whereas for individuals with a global focus increased flexibility should promote a shift to local processing, for individuals with a local focus it should promote a shift to global processing. Since the present participant sample contained comparable numbers of individuals with global and local focuses, it is understandable that the overall effect of the conflicting tendencies did not reach significance (i.e., there was no overall influence of prime valence). However, the results of separate analyses for each group supported the flexibility hypothesis. Comparing positive to neutral primes, for the global focus group positive affect significantly improved local processing, whereas for the local focus group positive affect significantly improved global processing. For the first time, it has been shown that this mirror-image pattern of responses is induced by a set of verbal affect primes that are uniform across participants and controlled on nonaffective dimensions, exhibiting an encouraging convergence with the results of the experiment using primes idiosyncratic to each participant that was reported by Baumann and Kuhl (2005). Why do experiences of positive emotion promote cognitive flexibility in this way? One possibility is that individuals in positive moods feel more secure to try new options and diverge from a single strategy, as shown by the tendency for happy people to seek more variety in their choices among safe, enjoyable alternatives (Kahn & Isen, 1993). From a neuropsychological perspective, it is also possible that the flexibility observed in good moods is mediated by release of the neurotransmitter dopamine (Isen, 1999).

The effects of negative primes did not differ significantly from those of neutral primes, and there was certainly no indication of reinforcing global precedence or local precedence further, as observed by Baumann and Kuhl (2005). Rather, the results were congruent with the conclusion of Isen et al. (1987) that negative moods do not necessarily impair creativity (and hence processing flexibility). Indeed, there was a non-significant tendency for negative primes to promote flexibility, just as positive primes did. In principle, this may suggest a possible role for the arousing effects of both positive and negative primes, although previous research has provided conflicting evidence on the issue of whether changes in cognition and visual processing due to positive and negative affect are mediated by arousal. Contrary to the arousal hypothesis, Isen et al (1987) found that the effect of positive affect on problem solving could not be reproduced by increasing arousal through exercise, and Olivers and Nieuwenhuis (2006) found that the effect of positive pictures on the attentional blink (i.e., impaired identification of a second target within rapid serial visual presentation) was not reproduced when negative pictures matched for arousal level were used. On the other hand, also in the attentional-blink paradigm, Anderson (2005) compared the identification of second targets that were either mildly positive but of a highly arousing sexual character, or more positive but less arousing, and found that identification improved more for the highly arousing words, and Keil and Ihssen (2004) found that identification was improved more for highly arousing unpleasant verbs than for less arousing pleasant verbs. Further, Robinson, Storbeck, Meier, and Kirkeby (2004) reported an interaction between valence and arousal, such that the valence of pictures was judged more rapidly with low than with high arousal when it was positive, but more rapidly with high than with low arousal when it was negative, and Schimmack (2005) observed a significant effect of a picture's arousal level on the speed both of problem solving and of line detection. Another general possibility with regard to the relation between positive and negative affect is that they constitute independent dimensions which do not necessarily affect cognition symmetrically (Tellegen, Watson, & Clark, 1999; Watson & Tellegen, 1985). If so, then the effect of negative primes would not be expected to bear a simple relation to that of positive primes.

In summary, Experiment 1 delivered relatively clear answers to both questions posed at the outset. First, affective primes have been shown to be capable of influencing local versus global processing even when these verbal stimuli are uniform and controlled, rather than tailored to individuals. Second, under these same conditions, positive affective primes have been shown to promote processing of the nonpreferred dimension regardless of its identity – that is, not only local detection in the case of global focus, but also global detection in the case of local focus. How reliable, and indeed robust to modification in experimental method, are these answers? In a second experiment, the use of verbal stimuli as affective primes was replaced by the use of pictorial stimuli. Previous studies suggest that valence effects can be considerably stronger for pictures than for words, even when the two types of stimuli are matched on arousal and absolute valence (e.g., Comblain, D'Argembeau, Van der Linden, & Aldenhoff, 2004; Kensinger & Schacter, 2006), and therefore it is possible that the effects of pictorial primes will differ substantially from those of verbal primes.

Experiment 2

Method

Participants. These were 23 students (8 men and 15 women) at the University of Warwick, with a mean age of 23.9 years.

Materials. Local and global stimuli were the same as in Experiment 1. Three sets of six pictures each were selected as affect primes (see Appendix) from the International Affective Picture System database (Lang, Bradley, & Cuthburt, 2005), a collection of 956 pictures with normative levels of judged valence and arousal. Positive primes (e.g., a baby, Slide Number 2070), neutral primes (e.g., abstract art, 7247), and negative primes (e.g., a hospital, 2205) were selected to have valences which were high (M = 8.05, SD = 0.24), medium (M = 5.16, SD = 0.26), and low (M = 2.54, SD = 0.93), respectively. In addition, there was matching on arousal levels for positive (M = 5.09, SD = 0.93) and for negative (M = 5.11, SD = 0.90) primes, with the level for neutral primes lower (M = 3.33, SD = 0.71). All pictures were displayed with the dimensions of 82 mm x 112 mm on a white background.

Design and procedure. These were generally the same as in Experiment 1, except for the use of picture primes instead of word primes, and the absence of first judging the pleasantness of the word primes. In addition, to buffer mood levels at the beginning and end of the session, participants judged the extent to which each member of a list of varied emotion words currently applied to them.

Results

Participants were divided into two groups on the basis of their mean reaction times to neutral primes. There were 15 participants in the global-focus group (lower mean RT for global than for local targets) and 8 local-focus participants (lower mean RT for local than for global targets; the data from one participant was discarded because she reported that she did not look at the picture primes during presentation).

A preliminary ANOVA was carried out on data from the combined global-focus and local-focus groups. Reaction times were not significantly influenced by the main effects of either target dimension, $F(1, 21) = 0.16$, or prime valence, $F(2, 42) = 1.30$. There was a significant interaction between the two, $F(2, 42) = 4.21$, $p < .05$, $\eta_p^2 = .167$, but none of the differences between prime valences reached significance for either global or local targets, for Bonferroni-adjusted pairwise comparisons, though reaction times were significantly lower for global than for local targets after neutral primes, $t(21) = 2.34$, $p < .05$.

When the preceding analysis was repeated with focus (global and local) added as a between-participant factor, focus was found to have no significant main effect, $F(1, 20) = 0.02$, and no significant interaction with valence, $F(2, 40) = 0.20$, but to modify significantly both the effect of target dimension, $F(1, 20) = 7.24$, $p = .01$, $\eta_p^2 = .266$, and the interaction between dimension and valence, $F(2, 40) = 11.07$, $p < .001$, $\eta_p^2 = .356$. To investigate the interaction between focus, target dimension, and valence further, separate ANOVAs were carried out for the global-focus and local-focus groups. As can be seen in Figure 3, the most striking consistency for the two groups was of a facilitation in the processing of the non-dominant dimension (i.e., local targets for the global-focus group, and vice versa) with positive as opposed to neutral primes.

For the global-focus group, there was a significant main effect of target dimension, $F(1, 14) = 5.35$, $p < 0.05$, $\eta_p^2 = .276$, but not of prime valence, $F(2, 28) = 0.89$. However, there was a highly significant interaction between dimension and valence, $F(2, 28) = 11.62$, $p < .001$, $\eta_p^2 = .454$. Bonferroni-adjusted pairwise comparisons within target dimensions showed that reaction times were significantly faster for positive, as compared to neutral, primes for local targets, $t(14) = 2.55$, and significantly slower for negative, as opposed to neutral, primes for global targets, $t(14) = 2.63$ (both $p < .05$). In addition, reaction times were significantly lower for global than for local targets for neutral primes only, $t(14) = 6.35$, $p < .001$. Error rates for the global-focus group are shown in the upper part of Table 2. ANOVA indicated that there was no significant interaction between target detection and prime valence, $F(2, 28) = 0.62$, or significant main effect, thus providing no evidence of a speed-accuracy trade-off.

For the local-focus group, there was no significant main effect of target dimension, $F(1, 6) = 2.18$, or prime valence, $F(2, 12) = 1.13$, but a significant interaction between dimension and prime valence, $F(2, 12) = 6.91$, $p < .05$, $\eta_p^2 = .535$. Bonferroni-adjusted pairwise comparisons within target dimensions showed that the only significant difference was that reaction times were significantly faster for positive, as compared to neutral, primes for global targets, $t(6) = 3.57$, $p < .05$. In addition, reaction times were significantly lower for local than for global targets for neutral primes only, $t(6) = 2.70$, $p < .05$. Error rates for the local-focus group are shown in the lower part of Table 2. There was no significant interaction between target detection and prime valence, $F(2, 12) = 2.02$, and no significant main effect, with thus no evidence of a speed-accuracy trade-off. In this experiment, there was no indication of potential trade-off as noted in Experiment 1, because both for global-focus participants with local targets and for local-focus participants with global targets, error rates were numerically lower (rather than higher) for positive than for neutral and negative primes. Analysis again confirmed that the overall pattern of interaction between focus, target dimension, and valence could not be attributed to speed-accuracy trade-off because the correlation between reaction time and error rate across conditions was numerically positive, though not significantly so, $r(12) = 0.37$.

General Discussion

The findings of Experiment 2 were closely in accord with those of Experiment 1, and the two sets of results may usefully be discussed together. Despite the employment of verbal primes in Experiment 1 and pictorial primes in Experiment 2, the effect of positively valenced primes in both experiments was the same. For the majority of participants with a global focus, positive affect significantly promoted local processing. For the minority of participants with a local focus, positive affect significantly promoted global processing. Experiment 1 demonstrated for the first time that this pattern of results is observed with verbal affect primes that are uniform across participants and balanced on nonaffective dimensions, and Experiment 2 demonstrated for the first time that this same mirror-image pattern of results is observed with affect primes consisting of pictures instead of words. In brief, the effect of positive primes on local versus global processing was to encourage the perceptual underdog, that is, to improve significantly detection performance for targets occurring on the nonpreferred dimension. Thus the effect of positive primes was not to confer a blanket advantage upon either local or global processing (cf Basso et al., 1996; Derryberry & Reed, 1998; Fredrickson, 2004; Gasper, 2004; Gasper & Clore, 2002), but instead can better be understood in terms of promoting attentional flexibility (Baumann and Kuhl, 2005). Given that in the present experiments affect was manipulated by means of words and pictures selected from corpora on the basis only of their normative properties, whereas in the experiment of Baumann and Kuhl (2005) it was linked directly to participants' personal life events, the consistency in outcome across these studies points to the robustness of the evidence for processing flexibility. According to this approach, positive affect makes it easier for individuals to diverge from their default processing strategies, whatever they may be. This process may also underlie the finding with eye-tracking that positive affect promotes increased attention to peripheral visual stimuli (Wadlinger & Isaacowitz, 2006).

The effects of negative primes upon detection within the nonpreferred dimension were not significant but tended also to be in the direction of facilitation. Thus they provided no support for viewing the effects of negative affect as necessarily the converse of those for positive affect (e.g., Green, Goldman and Salovey, 1993), although they may have provided an example of positivity offset, the tendency of the positivity system to respond more than the negativity system when evaluative input is relatively weak (Cacioppo & Bernston, 1994; Ito & Cacioppo, 2005). In both of the present experiments, no significant main (as opposed to interactive) effect of valence on responses was observed. This contrasted with the observation by Baumann and Kuhl (2005) of a significant overall impairment for negative (as opposed to positive and neutral) primes, including a tendency for negative primes to impair detection within the nonpreferred dimension which reached significance for local targets. It is possible that the overall balance among the effects of the primes in the present experiments was a consequence of the relatively high degree of methodological balance for prime selection in them. Finally, it may be noted that the effects of primes upon the processing of the preferred dimension were in general also not significant (except for the impairment of global performance by negative primes in Experiment 2), but tended to be complementary to those on the nonpreferred dimension, presumably reflecting a tradeoff in global versus local processing due to finite perceptual resources.

Some important issues for future research are raised by consideration of the distinction between global-focus and local-focus participants. In the present experiments, this categorisation was made simply in terms of mean reaction times with neutral primes. However, there is evidence that the distinction is linked to wider indices of differences among individuals. Local visual processing has been shown by Yovel, Revelle, and Mineka (2005) to be more potent among individuals who possess an obsessive-compulsive cognitive style, as assessed by the *Schedule for Nonadaptive and Adaptive Personality* (Clark, 1993). Local visual processing has also been shown by Billington, Baron-Cohen, and Bor (2008) to be enhanced among those with a general tendency toward systemizing, as assessed by *Systemizing Quotient* (Baron-Cohen, Richler, Bisarya, Gurunathan, & Wheelwright, 2003), itself associated by fMRI with activity in prefrontal, parietal, and extrastriate cortex. The links with broader processing styles suggest that memberships of global-focus and local-focus groups may be quite stable, and thus the extent to which these can be changed by an appropriate training regime is unclear. If membership can be reversed by training, however, it would be of particular interest to investigate whether the influence of affect also reverses, so that, for example, positive affect facilitates local processing in a currently global-focus--though originally local-focus--individual. Consideration of individual differences also raises the possibility of examining whether the influences of affect that have been observed here can be detected in other tasks performed by the same individuals. Rowe, Hirsh, and Anderson (2007) have demonstrated a significant correlation between the extent to which positive affect impaired performance in a flanker test of visual search (Eriksen & Eriksen, 1974) and the extent to which it improved performance on a semantic search task. Rowe et al. (2007) manipulated affect by means of mood induction rather than affective priming, and it would be informative to adapt the procedure of the present experiments to examine whether mood induction does indeed produce a comparable pattern of results.

Finally, the tendency found here toward a commonality of action between positive and negative primes (though not significant in the latter case) may suggest that an underlying role in affective priming is being played by arousal. As noted within the circumplex view of emotion (e.g., Posner, Russell, & Peterson, 2005; Russell, 2003), although emotional states such as those of being *elated* or *upset* can be characterised as possessing opposite valences, they can also be characterised as possessing comparable arousal levels. As stated earlier, despite some evidence against the hypothesis that arousal mediates the effects of positive and negative affect in cognition (Isen et al, 1987; Olivers & Nieuwenhuis, 2006), the results of a number of studies have provided support for this hypothesis (Anderson, 2005; Keil & Ihssen, 2004; Robinson et al., 2004; Schimmack, 2005). In the present paradigm, the results of Experiment 2 show that the effect of valence on perceptual flexibility could have been mediated by arousal at most only partially, not wholly, because positive and negative primes were matched on arousal, but nevertheless differed in their promotion of cognitive flexibility. Other recent work bears specifically on the possible involvement of arousal in the promotion by positive affect of processing flexibility. De Dreu, Baas, and Nijstad (2008) have reported that, in a brainstorming task, there was significant evidence in one of their four studies that cognitive flexibility (operationalised as the number of response categories produced) was associated with positive mood items which were activating in character (e.g., *happy*) rather than deactivating (e.g., *calm*); this contrasted with stronger evidence that cognitive persistence (the number of responses produced within a category) was associated with negative mood items which were activating (e.g., *fearful*) rather than deactivating (e.g., *depressed*). There is thus at least some evidence to support the hypothesis that it may be useful for future work to examine whether differential effects of arousal level can be observed within sets of valenced primes. Irrespective of this possibility, however, the present experiments appear to have delineated a reliable and significant facilitation of processing along nonpreferred dimensions as a consequence of exposure to positive affective primes of either a verbal or a pictorial nature.

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Appendix

Affect Primes

Positive	Neutral	Negative
	Experiment 1	
calm	pour	fail
rejoice	account	nervous
dawn	jump	rape
compliment	functional	disappoint
life	wide	kill
truth	south	guilt
	Experiment 2[a]	
1710	7160	2800
5833	7056	9571
2070	7247	2205
2091	2102	9440
1441	7000	9220
8501	7504	1930

Note. Primes are matched within rows.

[a]Slide numbers (Lang et al., 2005)

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Table 1.

Mean (and SD) of Error Rates (%) as a Function of Target Dimension and Prime Valence, for Global-focus and Local-focus Groups in Experiment 1

Target dimension	Prime valence: Positive		Neutral		Negative	
	Global focus					
Global	5.7	(5.7)	7.3	(8.9)	5.9	(7.0)
Local	10.1	(8.9)	8.3	(8.9)	7.1	(7.1)
	Local focus					
Global	9.4	(9.0)	9.2	(10.1)	7.8	(8.2)
Local	6.4	(7.5)	6.9	(7.9)	8.9	(9.3)

Table 2.

Mean (and SD) of Error Rates (%) as a Function of Target Dimension and Prime Valence, for Global-focus and Local-focus Groups in Experiment 2

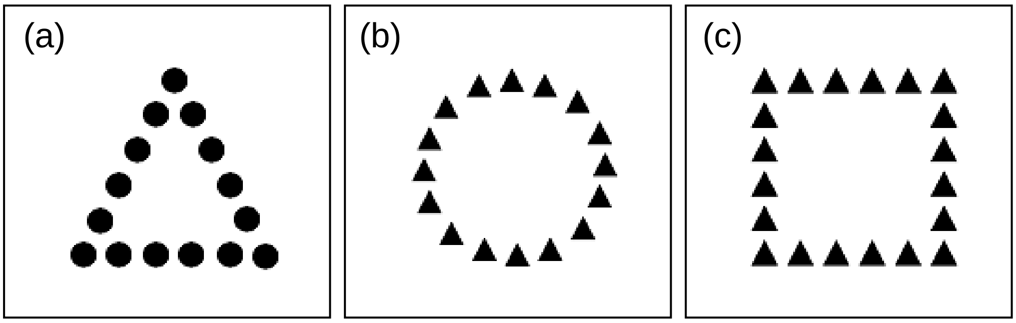
Target dimension	Prime valence: Positive		Neutral		Negative	
	Global focus					
Global	5.6	(8.1)	5.0	(6.9)	3.9	(7.6)
Local	3.3	(4.2)	3.9	(7.0)	3.9	(5.3)
	Local focus					
Global	7.2	(10.1)	13.1	(9.5)	15.5	(11.2)
Local	3.6	(4.6)	1.2	(3.2)	7.2	(5.8)

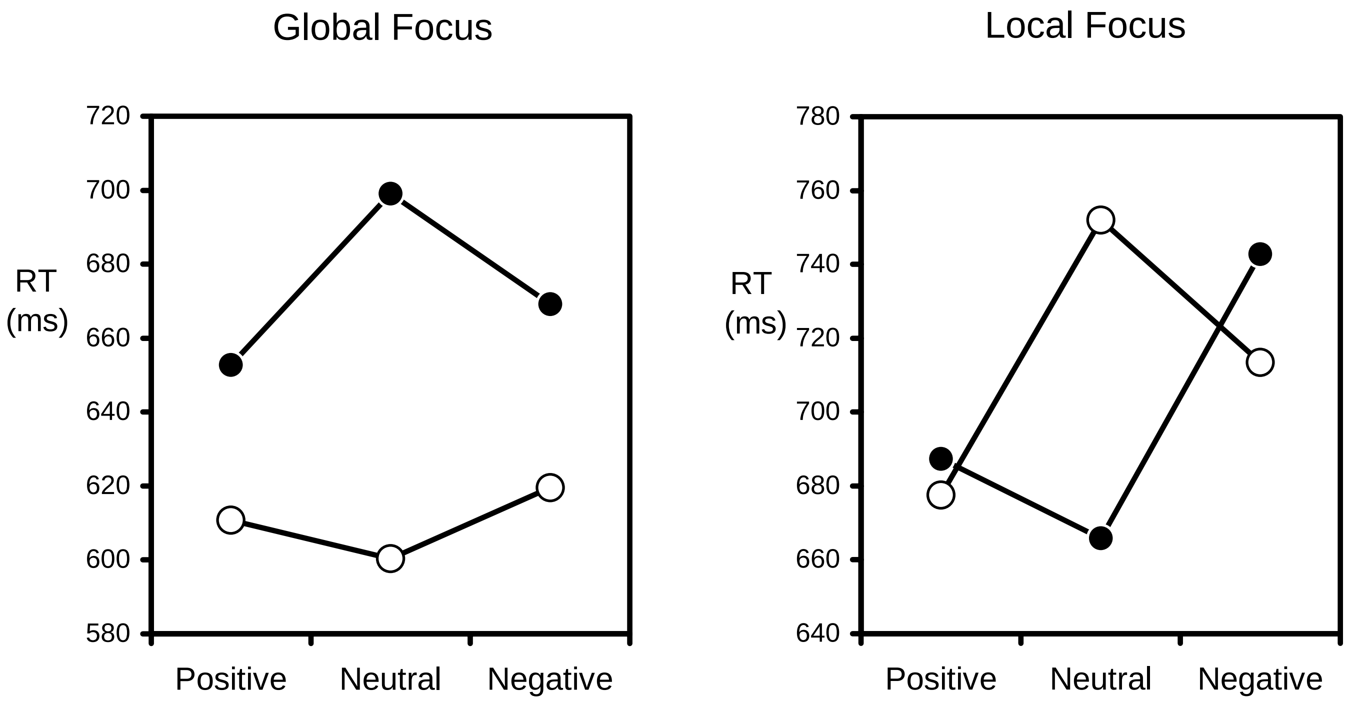
Figure Captions

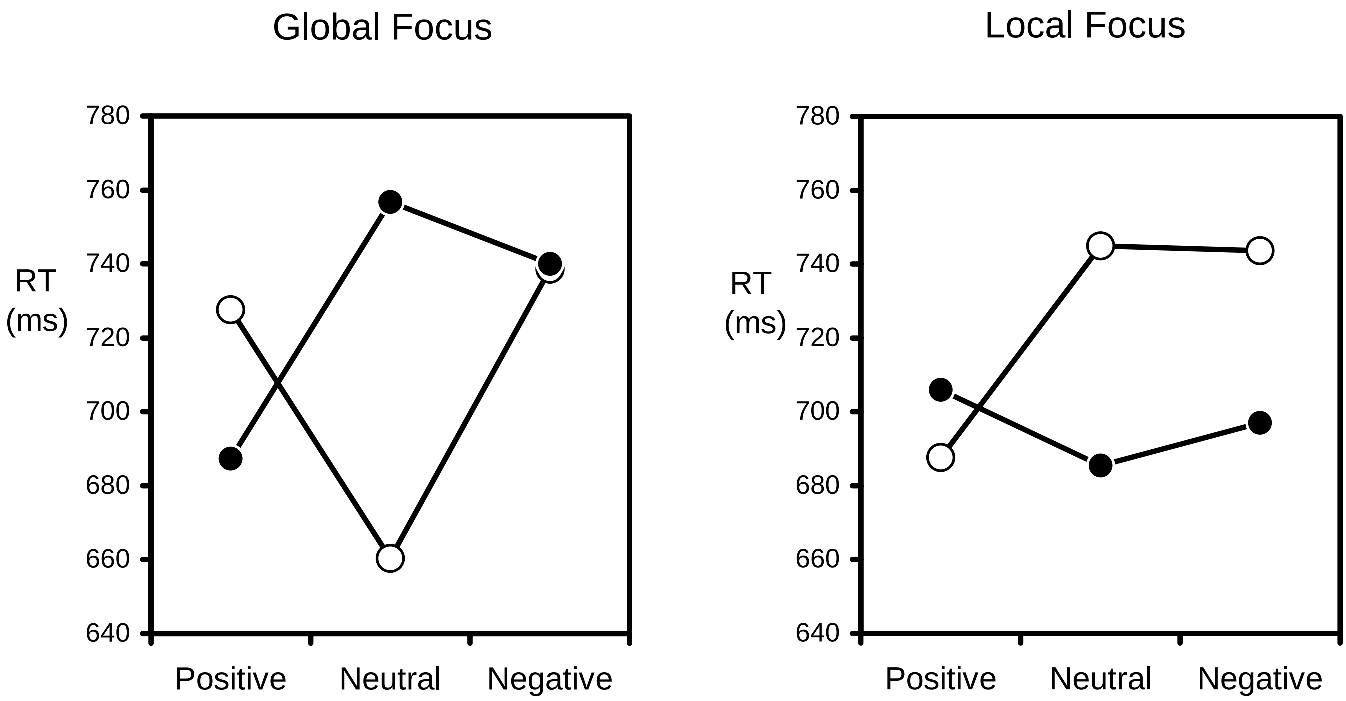
Figure 1. Local-global stimuli: For circle detection, (a) and (b) are positive and (c) is negative.

Figure 2. Mean reaction times in Experiment 1 for global detection (hollow circles) and local detection (solid circles) as a function of affective valence, for global focus and local focus groups.

Figure 3. Mean reaction times in Experiment 2 for global detection (hollow circles) and local detection (solid circles) as a function of affective valence, for global focus and local focus groups.


(a)
(b)
(c)


Global Focus
Local Focus
RT (ms)
720
700
680
660
640
620
600
580
780
760
740
720
700
680
660
640
Positive
Neutral
Negative


Global Focus
Local Focus
RT
(ms)
780
760
740
720
700
680
660
640
Positive
Neutral
Negative